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CHANGES IN TRACE MOTOR ACTIVITY-FOOD CONDITIONED
REFLEXES IN WHITE RATS DUE TO THE ACTION OF SINGLE
SMALL X-RAY DOSES

By L. S. Gorsheleva

- USSR -

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CHANGES IN TRACE MOTOR ACTIVITY-FOOD CONDITIONED
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Following is the translation of an article by L. S. Gorsheleva entitled "Izmeneniye Sledovykh Dvigatel'no-Pishchevykh Uslovnykh Reflektsov u Belykh Krys pri Odnokratnom Vozdeystvii Malyykh Doz Rentgenovykh Luchey" (English version above) in Zhurnal Vysshey Nervnoy Deyatel'nosti (Journal of Higher Nervous Activity), Vol. 10, No. 3, Moscow, 1960, pages 449-458.⁷

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The study of the effects of small doses of ionizing radiation on the organisms of animals is of great importance. However, only isolated works are available on this subject (Livshits ^[4], Kotlyarevskiy, Gorsheleva and Khozek ^[2], etc.).

In the present work we set ourselves the task of studying the effect of a single, five r dose of X-rays on the higher nervous activity of white rats. As indicators, in addition to conditioned concurrent reflexes, conditioned trace reflexes were employed, which form less readily (Gorsheleva ^[1]), and, at the same time are more sensitive to the action of ionizing radiation. The studies were carried out on nine rats by means of the L. I. Kotlyarevskiy food-motor activity method ^[3].

First, conditioned concurrent positive reflexes to 400 hertz (from the ZG-10-1954 sound generator; 14 volts, 50 ohms output resistance) and to the flash of a 25 watt green lamp were produced, with differentiation between these signals and a 200 hertz tone with three decibel damping.

In order to determine more accurately the typological characteristics of the experimental animals, special studies were conducted on the basic properties of their nervous systems.

Animals 2,3,4 and 9 had the very unbalanced type of the nervous system with greater or lesser predominance of the irritation process; animals 5,7,8 were of the strong, balanced type. Animal No. 1 was of the inter-mediate strong type, and No. 6, of the intermediate weak type.

Formation of a tracer reflex was carried out on a damped trace from a flash of a 25 watt red lamp. The action of the stimulus lasted three seconds and then a pause of seven seconds followed, after which food reinforcement was administered. After the tracer reflex had been formed (i.e., the positive motor reaction appeared not during the three-second action of the stimulus in the first inhibition phase of the reflex but during the pause in the second phase of the reflex), the pause was extended to 10 seconds.

The beginning of formation of the concurrent and tracer reflexes did not differ from one another. The reinforcement of the tracer reflex, on the other hand, took place much later than that of the concurrent reflex (Table 1), which attests to the difficulty of conditioning of such reflexes in white rats. The conditioned tracer reflex was quite stable.

The dynamic pattern consisted of nine stimuli which followed one another always in the same sequence: two concurrent positive tone stimuli (tone No. 1), two concurrent light stimuli (green light) and five tracer stimuli on the trace of a flash of a 25 watt red lamp.

After the tracer reflex had been reinforced, damped and restored, a single total irradiation was carried out by means of an RUM-3 X-ray apparatus (190 kw, 15 ma, dosage 25 r per minute with one mm Al and 0.5 mm Cu filters, focal distance 60 cm, irradiation time 12 sec.). The total irradiation dose was five roentgens.

In Table 2 are cited the experimental data of rat No. 3 which has the type of nervous system strongly unbalanced by stimulation. Experiment No. 152, conducted a day before the irradiation test, showed that the tracer reflex was correctly effected during the pause, in all five combinations. The power interrelations of the conditioned concurrent stimuli were correct. Within 30 minutes following termination of the irradiation test (experiment No. 154), there were observed slight changes in the concurrent reflexes, in the form of extension of the latent period of the first conditioned reflex in the pattern, and in a mildly pronounced paradoxical phase. The conditioned tracer reflex, on the other hand, showed substantial changes of a complex nature: in two combinations, the first inhibition phase disappeared and the

Table I

Formation of concurrent and tracer reflexes in white rats

№ бланк	2. Образование условного рефлекса на тон 400 мк (тон № 1)	3. Образование дифференц. на тон 200 мк (тон № 2)	4. Образование навязного условного рефлекса на зеленый свет	5. Образование следа от вспыхив. красн. лампы в 25 ст	6. Образование следа на затушев. л. с пин. шов. подк. креплен. за довод па-рест. пернода узы за этот период	7. Число сое-таия след-условия, раз-драж. с пин. шов. подк. креплен. за довод па-рест. пернода узы за этот период	8. Число дел-гат. ус-ловия, раз-драж. с пин. шов. подк. креплен. за довод па-рест. пернода узы за этот период		
1	5	12	85	3	26	5	232	262	122
2	10	28	76	2	2	5	210	260	172
3	8	8	58	2	2	5	180	199	104
4	8	6	139	6	14	8	188	196	88
5	6	6	80	4	56	3	129	162	109
6	5	5	80	4	40	3	77	133	75
7	4	4	25	2	98	2	101	112	59
8	3	7	80	1	7	2	90	178	89
9	3	3	131	3	3	2	57	146	103

1. No. of white rats
2. Formation of reflex to 400 hertz (tone No. 1)
3. Formation of differentiation to 200 hertz tone (tone No. 2)
4. Formation of concurrent reflex to green light
5. Formation of tracer reflex to the damped tracer from a red lamp flash of 25 watts
6. Number of combinations of the tracer stimulus with food reinforcement during the entire period of preparation
7. Number of conditioned motor reactions during the tracer pause for the period of preparation
8. appearance 9. reinforcement 10. appearance 11. reinforcement
12. appearance 13. reinforcement 14. appearance 15. reinforcement

Table 2

Rat No. 3

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000	1001	1002	1003	1004	1005	1006	1007	1008	1009	1010	1011	1012	1013	1014	1015	1016	1017	1018	1019	1020	1021	1022	1023	1024	1025	1026	1027	1028	1029	1030	1031	1032	1033	1034	1035	1036	1037	1038	1039	1040	1041	1042	1043	1044	1045	1046	1047	1048	1049	1050	1051	1052	1053	1054	1055	1056	1057	1058	1059	1060	1061	1062	1063	1064	1065	1066	1067	1068	1069	1070	1071	1072	1073	1074	1075	1076	1077	1078	1079	1080	1081	1082	1083	1084	1085	1086	1087	1088	1089	1090	1091	1092	1093	1094	1095	1096	1097	1098	1099	1100	1101	1102	1103	1104	1105	1106	1107	1108	1109	1110	1111	1112	1113	1114	1115	1116	1117	1118	1119	1120	1121	1122	1123	1124	1125	1126	1127	1128	1129	1130	1131	1132	1133	1134	1135	1136	1137	1138	1139	1140	1141	1142	1143	1144	1145	1146	1147	1148	1149	1150	1151	1152	1153	1154	1155	1156	1157	1158	1159	1160	1161	1162	1163	1164	1165	1166	1167	1168	1169	1170	1171	1172	1173	1174	1175	1176	1177	1178	1179	1180	1181	1182	1183	1184	1185	1186	1187	1188	1189	1190	1191	1192	1193	1194	1195	1196	1197	1198	1199	1200	1201	1202	1203	1204	1205	1206	1207	1208	1209	1210	1211	1212	1213	1214	1215	1216	1217	1218	1219	1220	1221	12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Table 2 continued from page 47

Время дня раздраж. начала опыта	Условия раздражителя	№ соче- таний	Время наблюд. действ. раздра- ж. в сек.	Общая степень раздра- ж. в сек.	Интен- сивность рефлекса в сек.	Условия рефлекса в сек.	при 3-х сек. дейст- вия	Следовой условный рефлекс										Итого усл. реф.	
								1	2	3	4	5	6	7	8	9	10		
2-й день после обучения																			
Опыт № 155, 23 VI 1956. Начало опыта 10 ч. 40 м.																			
0 м. 45 с.	Тон № 1	677	5	10	0,5	20													+++++
2 м. 10 с.	Тон № 1	678	5	10	1,0	25													+++++
3 м. 25 с.	Свет жел.	111	5	10	1,5	20													+++++
5 м.	»	112	5	10	0,5	10													+++++
6 м. 45 с.	Св. красн.	215					0,5/8	15										45	+++++
8 м. 30 с.	следовой	216					1/10	45										40	+++++
11 м.	То же	217						12	20									40	+++++
12 м. 20 с.	»	218					1/10	20	20									15	+++++
13 м.	»	219						1	1									45	+++++
4-й день после обучения																			
Опыт № 156, 25 VI 1956. Начало опыта 10 ч. 45 м.																			
1 м. 10 с.	Тон № 1	679	5	10	0,2	40													+++++
3 м. 45 с.	Тон № 1	680	5	10	0,2	30													+++++
5 м. 55 с.	Свет жел.	113	5	10	2,0	20													+++++
7 м. 25 с.	»	114	5	10	4,9	15													+++++
8 м. 20 с.	Св. красн.	210					0,5/10	10											+++++
11 м. 20 с.	следовой	211					1,5/15	25	15										+++++
13 м. 30 с.	То же	212					1,8/10	30	30										+++++
15 м. 30 с.	»	213					0,5/20	40	40										+++++
17 м. 40 с.	»	214						20	20										+++++

Table 2 continued on next page

Table 2 continued from page 57

Время дачи раствора от начала опыта	Условн. раздражитель	№ гоче- талия	Время исполн. дейст- вия разд- р. в сек.	Общая степень условн. разд- р. в сек.	Датум испыт. в сек.	Датум испыт. в сек.	Степень условный рефлекс										Нат. усл. реф.
							в паузе										
							1	2	3	4	5	6	7	8	9	10	
31-й день после облечения																	
Опыт № 137. 26 VI 1956. Начало опыта 10 ч. 55 м.																	
0 м. 30 с.	Тон № 1	681	5	10	1,0	25											+++++
3 м. 15 с.	Тон № 1	682	5	10	2,0	20											+++++
4 м. 45 с.	Свет жел.	115	5	10	6,0	20											+++++
6 м. 15 с.	»	116	5	10	0,5	20											+++++
7 м. 30 с.	Св. красн. следовой	215					1/10	15	20								+++++
10 м.	То же	216					1/40		20	30							+++++
11 м. 30 с.	»	217					0,5/20		20	30						30	+++++
13 м.	»	218					0,5/30		18	25						25	+++++
14 м. 30 с.	»	219					1/45										+++++
33-й день после овсяного облечения																	
Опыт № 163. 18 VII 1956. Начало опыта 10 ч. 5 м.																	
0 м. 30 с.	Тон № 1	703	5	10	0,5	40											+++++
2 м. 50 с.	Тон № 1	704	5	10	1,0	40											+++++
4 м. 50 с.	Свет жел.	137	5	10	2,0	20											+++++
6 м. 10 с.	»	138	5	10	3,0	30											+++++
7 м. 25 с.	Св. красн. следовой	240					1,5/15	28		30		22					+++++
9 м. 40 с.	То же	241						30		35		40					+++++
11 м. 15 с.	»	242								40		38				30	+++++
13 м. 10 с.	»	243															+++++
15 м.	»	244						20				35					+++++

Примечание. * Знак + означает наличие натурального условного рефлекса на вид и запах корма.
 ** Дробь означает величину денигательной условной реакции: числитель — латент, период ее, знаменатель — волнину в делен. манометр. шкалы.

Legend for Table 2 continued on next page

Legend for Table 2 continued from page 67

1. Time lapse between stimulation and the start of the experiment
2. Conditioned stimulus
3. No. of combinations
4. Duration of isolated effect of the stimulus
5. Total duration of the effect of the stimulus, sec
6. Latent period of the conditioned reflex
7. Conditioned reflex in manometric scale points
8. Conditioned tracer reflex
9. during the pause
10. at the three-second stimulus
11. Natural conditioned reflex *
12. Prior to irradiation
13. Experiment No. 152, 21 June 1956. Start of experiment: 10 hrs.
14. Tone No. 1
15. Tone No. 1
16. Green light
17. Red light tracer
18. same
19. 30 minutes after irradiation
20. Experiment No. 154, 22 June 1956. Start of experiment: 16 hrs 40 min
21. Tone No. 1
22. Tone No. 1
23. Green light
24. Red light tracer
25. Same
26. Notes: *Plus sign denotes the presence of a natural reflex to the sight and smell of food.
** Fraction denotes the magnitude of the conditioned motor reaction: numerator -- latent period; denominator -- magnitude in manometric scale points.
27. Second day after irradiation
28. Experiment No. 155, 23 June 1956. Start of experiment: 10:40
29. Fourth day after irradiation
30. Experiment No. 156, 25 June 1956. Start of experiment: 10 hours 45 m
31. Fifth day after irradiation
32. Experiment No. 157, 26 June 1956. Start of experiment: 10 hours 55 m
33. 25th day after irradiation
34. Experiment No. 168, 18 July 1956. Start of experiment: 10 hours 5 min.

Rat No. 5

Table 3

Время от начала опыта	Условный раздражитель	№ соединения	Средний условный рефлекс											Всего, реф.			
			Время между действиями, сек.	Число повторений в день	Число повторений в неделю	Условный рефлекс в виде реакции качающейся стрелки	В паузу										
							При 3-х сек. действия раздраж.	1	2	3	4	5	6		7	8	9

35 До облучения															
Опыт № 112. 13 VII 1956. Начало опыта 10 ч. 35 м.															
1 м. 50 с.	Тон № 1	550	5	10	1,0	30									++
4 м. 50 с.	Тон № 1	560	5	10	1,0	30									++
6 м. 20 с.	Свет жел.	131	5	10	2,0	25									++
7 м. 30 с.	»	132	5	10	2,0	25									++
9 м. 45 с.	Свет красн. следо-вой	158					20						25		+
11 м. 20 с.	То же	159					1/20 1/5			30				30	++
13 м. 30 с.	»	160											15		++
15 м.	»	161											15		++
16 м. 30 с.	»	162											15		++

36 2-й день, после облучения															
Опыт № 113. 14 VII 1956. Начало опыта 10 ч. 35 м.															
1 м. 5 с.	Тон № 1	561	5	10	2,0	30									++
3 м. 40 с.	»	561	5	10	2,0	40									++
5 м. 20 с.	Свет жел.	133	5	10	1,5	20									++
7 м. 10 с.	»	134	5	10	3,0	25									++
8 м. 55 с.	Свет красн. следо-вой	163										15		30	+
10 м. 40 с.	То же	164												15	++
12 м. 25 с.	»	165													++
14 м. 20 с.	»	166										30		30	++
16 м. 10 с.	»	167												30	++

Table 3 continued on next page

Table 3 continued from page 87

4-й день после облучения
10 VII 1959. Начало сыгта 10 ч. 30 м.

№	5	10	1,0	20	0,15	+
563	5	10	1,0	20	0,15	+
564	5	10	0,2	30	0,15	+
435	5	10	0,1	15	0,15	+
136	5	10		0	0,15	+
168						+
169						+
170						+
172						+
173						+

6-й день после опубликования
VI 1956. Издано орота 10 ч. 25 м.

[illegible]

21.8 Адам после обавування

[illegible]

/Legend for table 3 shown on next page 7

Legend for Table 3, shown on page 9
/column designations same as in Table 2, except as
follows: No. 35-44/

- 35. Prior to irradiation
- 36. Experiment No. 112, 13 July 1956. Start of experiment:
10 hrs 35 min.
- 37. Second day after irradiation
- 38. Experiment No. 113, 14 July 1956. Start of experiment:
10 hrs 35 min.
- 39. Fourth day after irradiation
- 40. Experiment No. 114, 16 July 1956. Start of experiment:
10 hrs 30 min.
- 41. Sixth day after irradiation
- 42. Experiment No. 116, 18 July 1956. Start of experiment:
10 hrs 25 min.
- 43. 21st day after irradiation
- 44. Experiment No. 126, 2 Aug. 1956. Start of experiment:
11 hrs 15 min.

animal reacted to the stimulus and its trace; in two combinations the conditioned motor reaction disappeared in both phases of the reflex; the tracer reflex remained in only one out of the five combinations.

On the second day after irradiation (experiment No. 155), in three combinations were observed a clearly expressed leveling phase in the concurrent reflexes and a disinhibition of the first inhibition phase of the tracer reflex. On the fourth day (experiment No. 156), in four combinations, the concurrent reflexes increased, while disinhibition of the first inhibition phase of the tracer reflex was observed. The second phase was invariably retained.

On the fifth day (experiment No. 157), in all five combinations there was a marked paradoxical phase in the concurrent reflexes, and a marked increase in the latent period of the concurrent optically conditioned reflex. The emergence of an orientation reaction was observed: the rats would turn their heads in the direction of an optically conditioned stimulus (a green light); this reaction had long ago been extinguished in the process of development of conditioned reflexes. During subsequent days, the described changes were observed in greater or lesser degrees: the paradoxical phase changed into a leveling phase, and the tracer reflexes were impaired principally in the direction of disinhibition of the first phase. On the 25th day after irradiation, the nervous activity of

the animal began to become normal (experiment No. 168). The magnitude of the concurrent reflexes was also somewhat higher as compared to norm, the power interrelations of the stimuli were correct, and in the majority of combinations (four out of five) the tracer reflex corresponded to the requirements for this type of conditioned reflex.

In Table 3 are cited the data of rat No. 5 which has a strong, balanced type of nervous system. In this animal, on the second day after irradiation (experiment No. 113), no changes in conditioned reflexes were observed as compared with the initial level (experiment No. 112). The first inhibition phase of the conditioned tracer reflex was observed in four out of five combinations, whereas in normal, unirradiated animals its disinhibition was observed at times. Thus, active inhibition in this rat increased during the first stage following irradiation.

On the fourth day following irradiation (experiment No. 114) there was observed a decrease and, later, a disappearance of the conditioned concurrent reflex to the flash of a green lamp, whereas the conditioned tracer reflex remained intact in all five combinations. This disturbance should be regarded as a peculiar paradoxical phase.

On the sixth day there were observed disturbances of the tracer reflex: in three combinations there occurred a disinhibition of the first inhibition phase with preservation of the second phase, and in one combination the conditioned motor reaction was absent in both phases of the tracer reflex. Subsequently there was most frequently observed, against the background of an enhanced general excitation of the animal, a leveling and a paradoxical phase in the concurrent reflexes, and at the same time a relative preservation of the tracer reflex. On the 21st day the conditioned reflexes became normalized (experiment No. 126).

A peculiar paradoxical phase, in which the concurrent, optically conditioned reflex disappeared while the tracer reflex which had developed on the dying trace of the optical stimulus of the same intensity retained its strength, was observed also in other experimental animals (Figs. 1,2,3). It can be seen clearly that under normal conditions the concurrent and tracer reflexes to light were sufficiently strong in the animal (Fig. 1). The latent period of a conditioned concurrent reflex to green light equaled two seconds, whereas the conditioned tracer reflex appeared within 0.5 seconds after the switching-off of the stimulus; the animal at this stage during the pause made several movements which gradually increased with the

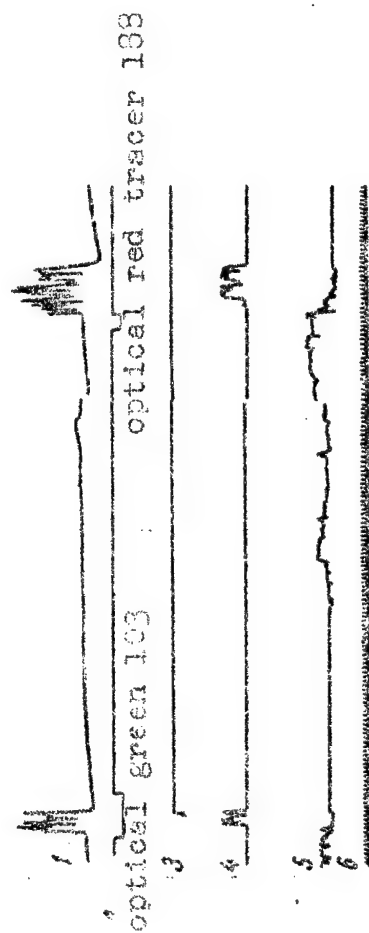


Fig. 1. Kymogram of rat No. 4. Optically conditioned concurrent and tracer reflexes in norm: 1 - special motor conditioned reaction, 2 -- stimulus, 3 -- unconditional reinforcement, 4 -- movement of the feed box, 5 -- the general motor reaction -- actography, 6 -- time in seconds

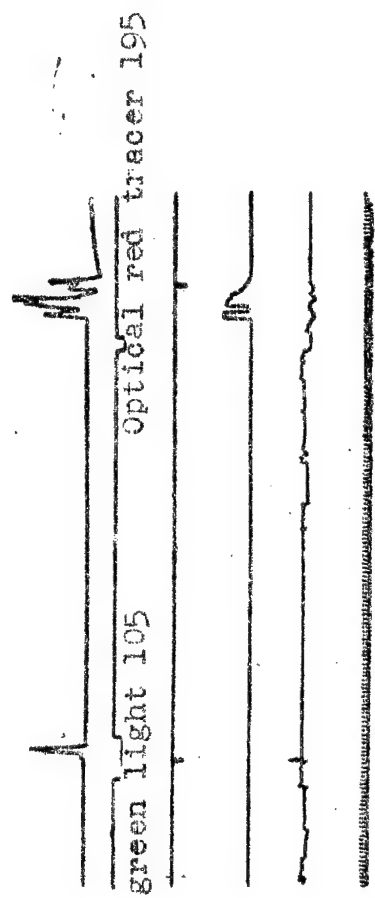


Fig. 2. Kymogram of rst No. 4 on the second day after irradiation. The designations are the same as in Fig 1.

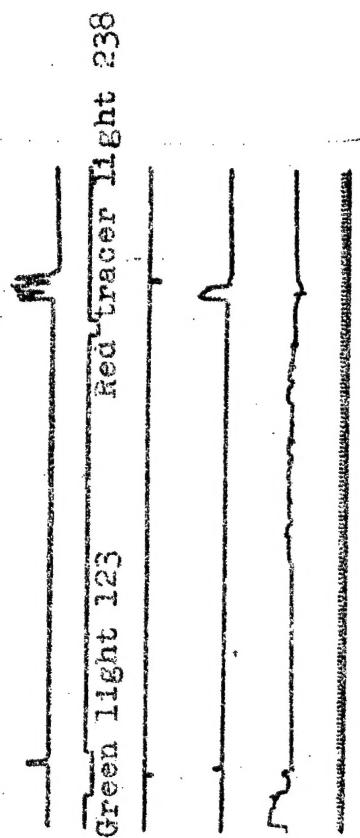


Fig. 3. Kymogram of rat No. 4 on the 19th day after irradiation.

approach to reinforcement. On the second day after irradiation (Fig. 2) the conditioned reaction to green light disappeared, but the conditioned tracer reflex remained and even acquired a more pronounced character: the motor reaction began during the fourth second of the tracer pause. The same was observed also on the 19th day after irradiation (Fig. 3).

Thus, in animals with the excitable type of nervous system (rat No. 3 and others) the disturbances appeared much earlier and lasted somewhat longer than in the representatives of the strongly balanced type (rat No. 5 and others).

In the majority of animals the disturbances of the tracer reflex, which had become much more frequent after irradiation, decreased subsequently to the initial level and even below it. The concurrent reflexes increased steadily shortly after irradiation in some animals (rats 2, 6), while in others a wave-like pattern of disturbances was observed: during the initial stage following irradiation the conditioned reflexes decreased, then increased and finally decreased again (rats 1, 4, 8). In some, on the contrary, these reflexes were higher at first, then decreased, then rose again (rats 7, 8). Various changes of the concurrent reflexes in response to sound and light were observed: in some animals the conditioned reflex to sound increased; in others this reflex showed no change but the reflex to the light stimulus increased. The undulating course of conditioned reflex changes attested, apparently, to the fact that a small X-ray dose, while exerting a stimulating effect, at the same time led to the struggle of basic cortical processes; it was not, however, as pronounced and protracted as the one observed by us following the administration of X-rays in a 50 r dose.

Conclusions

1. A single X-ray irradiation of rats with a five roentgen dose induces mildly pronounced disturbances of power interrelations of conditioning stimuli and in the majority of cases, an accompanying increase of the conditioned reflex to light.

2. Changes in the conditioned tracer reflex are characterized basically by the impairment of its inhibitory phase, i.e., by the emergence of a conditioned motor reaction during the action of the stimulating agent: in the second phase the presence of a motor reaction during

the pause is retained.

3. There were observed cases in which, within the limits of the optical analyzer, the concurrent reflex disappeared, while the tracer reflex which had developed on a trace of a stimulus of equal force retained its full strength.

4. The conditioned reflex changes proceed in an oscillating manner during the period following irradiation, which attests to the struggle of basic neural processes in the cerebral cortex.

5. Normalization of conditioned reflexes in the majority of animals takes place between the 21st and 25th days following irradiation.

6. A certain variability in the period before the changes in the conditioned reflex is related to the typological peculiarities of the animals, and the property of steadiness of nervous processes obviously contributes to the greater stability of the organism in the presence of ionizing radiation.

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